Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Scholars Research Library

Central European Journal of Experimental Biology, 2015, 4 (2):17-23
(http://scholarsresearchlibrary.com/archive.html)

Central European Journal of Experimental Biology
Scholars Research Library
ISSN: 2278–7364

Effective soil resource recycling with a new biodegradation method towards organic soil management – A case study from Howrah Krishi Vigyan Kendra, ICAR

Mukhopadhyay K.[1*], Mukherjee S.[1], Seal A.[2], Bera R.[2] and Dolui A.K.[3]

[1]*Howrah Krishi Vigyan Kendra, Bidhan Chandra Krishi Viswavidyalaya, Jagatballavpur, Howrah, West Bengal, India*
[2]*Inhana Organic Research Foundation (IORF), 168 Jodhpur Park, Kolkata, West Bengal, India*
[3]*Institute of Agricultural Science, Calcutta University, Kolkata, West Bengal, India*

ABSTRACT

Composting plays an important role in organic soil management and presently there has been a rising quest for farmer friendly composting technology, which can enable compost production using any type of available raw materials. A study was done in Howrah Krishi Vigyan Kendra (KVK), ICAR during 2013 to 2015 to evaluate the effectivity of Novcom composting method towards production of quality compost using on-farm available resources like water hyacinth, poultry litter and banana stumps. Novcom composting process (irrespective of the type of raw material used) completed within a short time frame of 21 days and laboratory analysis as per international standards confirmed that, the compost under this method was mature, non- phytotoxic and ready to use for any type of agricultural soil management from nursery tubes to main field operation. Highest nutrient content was obtained in case of Novcom poultry litter compost (4.33) with comparatively higher compost mineralization index (2.38). Where as self-generated microbial population was highest in case of Novcom banana stump compost (36.2 x 10^{15}), closely followed by the others. Evaluation of Compost Quality Index (CQI) indicated highest value (6.17) in case of Novcom water hyacinth compost followed by Novcom poultry litter compost (4.89) and Novcom banana stump compost (4.74). The study indicated that Novcom composting method on account of the wide choice of raw materials, short biodegradation period and quality end product; could be useful towards infiltration of composting habits among farming community, in order to enable on-farm resource recycling and effective organic soil management.

Keywords: Novcom composting, farmers' friendly technology, N appreciation, maturity, phyto-toxicity, compost quality index.

INTRODUCTION

The continuous depletion of soil and crop productivity within only a few decades of inception of chemicalized farming practices substantiates the deterioration of soil health and resilience due to application of chemical fertilizers and pesticides. At the same time there has been a growing conviction that compost is the best option available to restore and enhance the soil potential in order to restrict the decline of crop yield as well as to meet the ever increasing demand of food and feed.

Novcom composting method, a new biodegradation process is gaining popularity among the organic tea growers of Darjeeling and Assam due to its simplicity, faster biodegradation rate, good quality end product and lower economics (Seal et al, 2012; Dolui et al, 2014). The composting technology was developed by Dr. P. Das Biswas, pioneered in scientific organic tea cultivation in India (Barik et al, 2014) and developer of an organic package of practice called Inhana Rational Farming (IRF) Technology (Chatterjee et al, 2014). Novcom composting method emerged as a viable option as found from FAO funded project report (Bera et al, 2013). In this process compost is produced within 21 days and no specific infrastructure is required which may prove helpful for large scale adoption within common farmer's class. Present study was undertaken with the objectivity of making quality compost with available resources, which are available in plenty in Howrah district towards enhancement of soil quality. Specially raw materials like water hyacinth, poultry litter, banana stump, which are available in plenty in Howrah district, but not utilized in large scale for composting due to absence of farmers friendly technology was tried out to evaluate whether the composting technology can be effectively used to make quality compost.

MATERIALS AND METHODS

Novcom Composting Method:

Novcom solution: Novcom solution is a research product of Inhana Biosciences, (a R&D organization based in Kolkata, India) and is developed under the element energy activation (EEA) principle. Radiant solar energy is stored in plants and the bound stored energy components are extracted from energy-rich plant parts using a specific extraction procedure and subsequently potentized in the order of 10^3 to 10^4 (Seal et al, 2012). The solution contains biologically activated and potentized extracts of Cynodon dactylon, Sida cordifolia L. and Ocimum bascilicum. This solution is used during erection of the Novcom compost heap and further on days 7 and 14 of composting, i.e. during heap restructuring (as described below). Henceforth, this process is known as the Novcom composting method and the end product as Novcom compost.

Total requirement of Novcom solution: Total 250 ml Novcom solution is required for 1 ton of raw materials (100 ml on day 1followed by 75 ml each, on day 7 and day 14).

Preparation of Novcom compost:

Day 1 : At a selected upland and flat area chopped raw materials (water hyacinth or banana stump) or poultry litter was spread to make a base layer measuring 10 ft. in length, 5 ft. in breadth and 1 ft. in thickness. This layer was sprinkled thoroughly with diluted Novcom solution (5 ml/ ltr.of water) and over this layer, a layer of cow dung (3 inches in thickness) was made followed by a second layer of chopped raw material, once again 1 ft. in thickness. The raw matter layer was once again sprinkled with diluted Novcom solution (5 ml/ ltr. of water) and the process was continued till the total height reached to about 6 ft. After construction of each layer of raw matter it was compressed downward from the top and inward from the sides for compactness.

Day 7 : On the 7th day compost heap was demolished and churned properly. The material was next laid layer wise and after making each layer diluted Novcom solution (5 ml/ ltr.) was sprinkled thoroughly as done on 1st day. After seven days the volume of the composting material decreased due to progress in decomposition process. Hence, to once again maintain the heap height to about 6 ft.; the length and breadth of the heap was maintained at 6 ft. x 6 ft. respectively. The heap was once again made compact as described earlier.

Day 14 : The same process was repeated as on day 7 and to maintain heap height to about 6 ft., the length and breadth of the heap was further reduced to 6 ft. x 4 ft. respectively.

Day 21 : The composting process was complete and compost was ready for use.

Analysis of compost samples :

12 samples representing individual compost heaps were collected from different Novcom compost heaps and analyzed for different quality parameters following the methodology described in Seal *et al.*, (2012). Part of the compost analysis was done in the in-house laboratory of Howrah KVK and part in the laboratory of Inhana Biosciences. Compost Quality Index was calculated as per the methodology of Bera *et al.*,(2013b).

$$\text{Compost Quality Index (CQI)} = \frac{NV_{NPK} \times MP \times GI}{\text{C/N ratio}}$$

Where NV_{NPK} = Total nutrient value in terms of total ($N+P_20_5+K_20$) percent.
MP = log_{10} value of total microbial population in terms of total bacteria, total fungi and total actinomycetes.
GI = Germination Index.

Classification of compost as per Compost Quality Index.

Compost Quality Index (CQI)	Compost Quality Classification
< 2.00	Poor
2.00 – 4.00	Moderate
4.00 – 6.00	Good
6.00 – 8.00	Very Good
8.00 – 10.00	Extremely Good

Pic 1 : Novcom banana stump compost as apart of MSC project at Howrah KVK

Table 1A: Quality parameters of Novcom compost prepared from different raw materials at KVK, Howrah

Sl. No.	Parameter	Novcom compost		
		Water Hyacinth	Poultry Litter	Banana Stump
		Physical Parameters		
1.	Moisture percent (%)	56.79 – 67.45* (63.21) [±1.12]	49.89 – 58.32 (55.73) [±1.11]	57.84 – 64.80 (59.04) [±0.85]
2.	Bulk density(g/cc)	0.39 – 0.45 (0.42) [±0.01]	0.42 – 0.48 (0.45) [±0.01]	0.36 – 0.44 (0.42) [±0.02]
3.	Porosity (%)	61.24 – 65.31 (62.72) [±1.12]	65.42 – 68.18 (68.11) [±0.73]	57.20 – 62.02 (60.04) [±1.04]
4.	Water holding capacity (%)	181 – 243 (212) [±3.73]	241 – 289 (269) [±3.22]	185 – 219 (211) [± 2.79]
Physicochemical Parameters				
5.	pHwater (1 : 5)	7.11 – 7.74 (7.24) [±0.20]	6.51 – 8.09 (7.79) [±0.13]	6.69 – 7.65 (7.11) [±0.32]
6.	EC (1 :5) dSm-1	2.21 – 2.94 (2.64) [±0.33]	2.44– 3.39 (2.92) [±0.31]	1.76 – 2.10 (1.94) [±0.16]
7.	Total Ash Content (%)	43.51 – 49.39 (46.29) [± 2.11]	55.12 – 58.74 (56.89) [± 1.83]	40.53 – 43.21 (41.87) [± 0.82]
8.	Total Volatile Solids (%)	50.44– 56.39 (53.71) [± 2.19]	41.26– 44.88 (43.11) [± 2.01]	56.79– 59.47 (58.13) [± 0.74]
9.	Organic Carbon (%)	28.02 – 31.13 (29.84) [± 1.11]	22.92 – 24.93 (23.95) [± 1.08]	31.55 – 33.04 (32.29) [± 1.09]
10.	CEC ($cmol(p+)kg^{-1}$)	169 - 239 (213) [± 10.11]	194 - 264 (230) [± 9.02]	165 - 217 (190) [± 8.80]
11.	Compost Mineralization Index	1.38 – 1.76 (1.55) [± 0.13]	2.21 – 2.56 (2.38) [± 0.18]	1.23 – 1.37 (1.30) [± 0.13]
Fertility Parameters				
12.	Total Nitrogen (%)	1.81 – 2.27 (2.09)[± 0.03]	1.69 – 2.14 (1.83)[± 0.08]	1.68 – 1.96 (1.79)[± 0.05]
13.	Total P_2O_5 (%)	0.89 – 1.11 (0.95) [±0.05]	1.27 – 1.37 (1.32) [±0.02]	0.83 – 1.09 (0.94) [±0.04]
14.	Total K_2O (%)	1.05 – 1.36 (1.15) [± 0.07]	0.99 – 1.28 (1.18) [± 0.06]	1.54 – 1.69 (1.58) [± 0.06]
15.	C/N ratio	13.16:1 – 15.07:1 (14:29) [±0.41]	13.24:1 – 14.19:1 (13.09:1) [±0.11]	16.86:1 – 18.78:1 (17.46:1) [±0.10]

Range Value (Mean value) [±S.E.]

Table 1B: Quality parameters of Novcom compost prepared from different raw materials at KVK, Howrah

Sl. No.	Parameter	Novcom compost		
		Water Hyacinth	Poultry Litter	Banana Stump
Stability Parameters				
16.	CO_2 Evaluation Rate ($mgCO_2$–C/g OM/day)	1.74 – 3.41* (2.19) [± 0.11]	2.27 – 3.92 (2.87) [± 0.10]	1.53 – 2.79 (2.21) [± 0.18]
Microbial Parameters (total count) (per gm moist compost)				
17.	Bacteria	(18–54) $x10^{16}$ ($37 x10^{16}$) [$5.1x10^{16}$]	(17–24) $x10^{16}$ ($21 x10^{16}$) [$3.3x10^{16}$]	(23–49) $x10^{16}$ ($33 x10^{16}$) [$5.3x10^{16}$]
18.	Fungi	(21 – 43) $x10^{14}$ ($29 x10^{14}$) [$2.9 x10^{14}$]	(11 – 22) $x10^{14}$ ($16 x10^{14}$) [$1.2 x10^{14}$]	(24 – 48) $x10^{14}$ ($31 x10^{14}$) [$2.2 x10^{14}$]
19.	Actinomycetes	(14–31) $x10^{14}$ ($26 x10^{14}$) [$1.8 x10^{14}$]	(7–10) $x10^{14}$ ($9 x10^{14}$) [$1.1 x10^{14}$]	(21–39) $x10^{14}$ ($31 x10^{14}$) [$2.1 x10^{14}$]
Maturity & Phytotoxicity Parameters				
20.	Seedling Emergence (% of control)	93 – 121 (113) [±2.40]	89 – 97 (93) [±1.31]	94 – 114 (108) [±2.13]
21.	Root Elongation (% of control)	91 – 115 (99) [±2.05]	91 – 106 (95) [±2.25]	93 – 117 (102) [±3.03]
22.	Germination Index (phytotoxicity bioassay)	0.84 - 1.43 (1.12) [±0.06]	0.80 – 0.98 (0.89) [±0.03]	0.87 - 1.32 (1.10) [±0.04]
Compost Quality				
23.	Compost Quality Index (CQI)	4.68 – 7.86 (6.17) [±0.42]	4.08 – 5.82 (4.89) [±0.37]	3.48 – 5.96 (4.74) [±0.42]
24.	Compost Quality Class	Good to Very Good	Good	Moderate to Good

Range Value (Mean value) [±S.E.]

Evaluation of compost quality

Qualitative evaluation of compost samples was done in terms of physicochemical properties, nutrient content, microbial potential, stability and phytotoxicity parameters (Table 1).

Physical Parameters

Average moisture was varied from 55.73 to 63.21 percent, which may be placed in the high value range (40 to 50) as suggested by Evanylo, (2006). All the compost samples appeared dark brown in colour with an earthy smell, deemed necessary for mature compost (Epstein, 1997). Water holding capacity of 211 to 269 percent, may be placed in the high value range (standard range of 100 to 200 with preferred value of >100) as suggested by Evanylo, (2006). The water holding capacity may be attributed to the abundance of humus particles in the compost (Trautmann and Krasny, 1997) and the addition of such compost in soil helped in retaining soil moisture during the dry months.

Physicochemical Parameters

The pH value of the compost samples ranged between 7.11 and 7.79, with a mean of 7.38, which was well within the stipulated range for good quality and mature compost (Jime´nez and Garcia 1989). Electrical conductivity of the compost samples ranged between 1.94 and 2.92 with a mean of 2.5 dSm-1, indicating its high nutrient status at the same time being safely below (< 4.0) the stipulated range for saline toxicity. The organic matter content of compost is a necessity for determining the compost application rate to obtain sustainable agricultural production. Organic carbon content in the compost samples ranged between 23.95 and 32.29 %, with a mean value of 28.69 %, which met the standard value of >19.4% suggested by Australian Standard 4454 (AS 1999) for nursery application. Cation exchange capacity (CEC) is one of the most important properties of compost and is usually closely related to fertility. The CEC of the compost samples ranged between 190 and 230 cmol(p+) kg^{-1}, which is comparable with values obtained for good quality compost (Seal *et al*. 2012).

Fertility Parameters

The total nitrogen content in the compost samples ranged between 1.79 and 2.09 percent, which was well above the reference range (1.0 to 2.0 percent) suggested by Watson (2003). The high N value with respect to standard range might indicate higher fixation of atmospheric N within compost heap during *Novcom* composting process (Seal *et al*, 2012). Total phosphate (0.94 to 1.32 percent) and total potash content (1.15 to 1.58 percent) were also higher than the minimum suggested standard (0.6 to 0.9 percent and 0.2 to 0.5 percent respectively) by Watson (2003). In comparison to total NPK value obtained by other workers working with water hyacinth composting with different composting process (Dhal et al 2012) clearly showed higher nutrient value obtained in case of *Novcom* compost. This indicates intense biodegradation in case of *Novcom* compost resulting in minimum loss and appreciation of

initial value (in case of N) contribute to the comparatively higher nutrient in the final compost samples as also evidenced by Bera *et al*, 2013. C/N ratio varied from 13: 1 to 17: 1 indicates all the compost samples were mature and suitable for soil application.

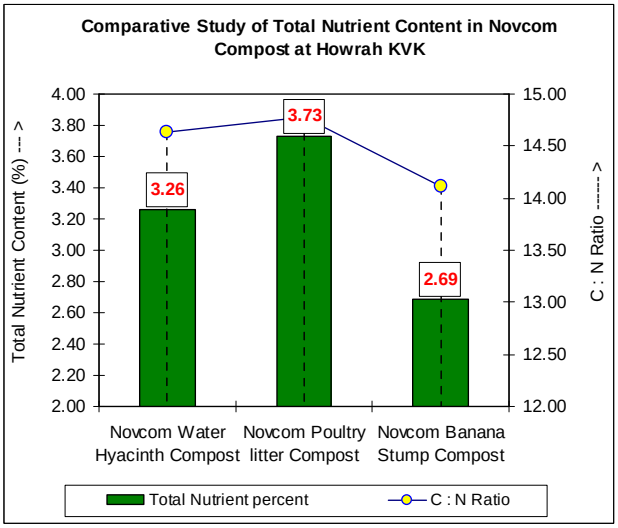

Fig 1: Comparative study of total nutrient content in Novcom compost at Howrah KVK

Pic 2: Analysis of Compost N in the in-house laboratory of Howrah KVK

Microbial parameters

The microbial population, their biomass and activity, are the key parameters that can also be used to elucidate the composting process. In open-air composting processes, colonization of microbes in compost material occurs naturally during heap construction as well as at the time of turning of heap.

Pic 3 : Novcom water hyacinth compost and Novcom poultry compost at Howrah Krishi Vigyan Kendra, ICAR under soil resource recycling programme

Total count of bacteria, fungi and actinomycetes in per gram moist compost sample was (21-37) x 10^{16}, (16-31) x 10^{14} and (9-31) x 10^{14} c.f.u. respectively. Such high generation of microbial population might have been possible due to the generation of an ideal micro atmosphere within composting heap as influenced by the application of *Novcom* solution


Pic 4 : Demonstration of Final Compost sample and crop produced using Novcom compost during 'Technology week 2015' at Howrah KVK, ICAR

Stability and Phytotoxicicty Parameter

Microbial respiration formed an important parameter for determination of compost stability. Mean respiration or CO2 evolution rate of all composts (2.19 to 2.87 mg/day) was more or less within the stipulated range (2.0 - 5.0) for stable compost as proposed by Trautmann and Krasny (1997). The phytotoxicity bioassay test, as represented by germination index provided a means of measuring the combined toxicity of whatever contaminants may be present (Zucconi *et al.,* 1981). Germination index value of >1.0 as obtained in case of *Novcom* compost indicated not only the absence of phytotoxicity (Tiquia *et al*., 1996) in the compost but moreover, it confirmed that the compost enhanced rather than impaired germination and radical growth (Trautmann and Krasny, 1997).

Compost Quality Index

In order to classify the different types of compost, four specific quality parameters (which were combination of one or more properties that regulate the nutrient mineralization from compost as well as its post soil application affectivity) were taken up to formulate Compost Quality Index (Bera *et al*, 2013). Classification of compost as per quality will enable the producer to get a fair idea about any compost choice and taking decision for soil management. As per analysis of compost quality index, Novcom water hyacinth compost scored highest value (6.17) followed by Novcom poultry litter compost (4.89) closely followed by Novcom banana stump compost (4.74). As per compost quality class, all the compost varied from good to very good compost class with few exceptions.

CONCLUSION

Analysis of compost samples produced under Novcom composting method from different type of raw materials indicated that quality compost could be produced using this composting method. At the same time, compost can be produced within 21 days without any specific infrastructure and the process is most convenient and easy to adopt. The study indicated that, Novcom composting method might be useful towards implementation of successful organic soil management among all farming community. Non selectivity of raw materials under Novcom composting method will enable effective resource recycling programe utilizing all available raw materials and easy methodology and non requirement of any infrastructure helps to increase its adoptability among all farming class from marginal farmer to large farmer as per their requirement and resource availability.

REFERENCES

[1] A K Barik, A K Chatterjee, B Mondal, A Datta, S Saha, R Nath, R Bera, A Seal. *The International Journal Of Science & Technoledge*, **2014**, 2(4): 147-155.
[2] A K Chatterjee, A K Barik, G C De, A K. Dolui, D Majumdar, A Datta, S Saha, R Bera, A Seal. *The International Journal Of Science & Technoledge*, **2014**, 2(6): 377-395.
[3] A K Dolui, A Som, K Mukhopadhyay, S Mukherjee, R Bera, and A Seal. *J. Nat. Prod. Plant Resour*., **2014**, 4 (3):44-47.
[4] A Seal, R Bera, A K Chatterjee and A K Dolui. *Archives of Agronomy and Soil Science*, **2012**, 58(9): 995-1012.

[5] Australian Standards. 4454: 1999. Composts, soil conditioners and mulches. *Standards Association of Australia*, Homebush, NSW, **1999**.
[6] E Epstein **1997**. The Science of Composting. Technomic Publishing, Lancaster, PA. Ipek, U.,Obek, E., Akca, L., Arslan, E.I., Hasar, H., Dogru, M., and Baykara, O. *Bioresource Technology*, **2002**, 84 : 283–286.
[7] F Zucconi, A Fera, M Forte, and M dc Bertoldi.
International Journal Of Environmental Sciences, **2012**, 2 (3): 1223-1238.
[9] G. Evanylo. Compost Maturity and Indicators of Quality: Laboratory Analyses and On-Farm Tests. http://www.mawaterquality.org/industry_change/compost_school/Compost%20quality_Evanylo.pdf. **2006**.
[10] I. E. Jime`nez, and PV. Garcia. Evaluation of city refuse compost maturity: A Review. *Biological Wastes*, **1989**, 27: 115-42.
[11] M. E. Watson. *Extension Fact sheet*. Ohio State University. http://ohioline.osu.edu. **2003**.
[12] N M Trautmann, and M E Krasny. *Composting in the classroom*. http://www.cfe.cornell.edu/compost/schools.html, **1997**.
[13] R Bera, A Datta, S Bose, A K Dolui, A K Chatterjee, G C Dey, A K Barik, R K Sarkar, D Majumdar, A Seal. *International Journal of Scientific and Research Publications (IJSRP)*, **2013b**, 3(6):1-11.
[14] S M Tiqua, NFY. Tam, IJ. Hodgkiss. *Environmental Pollution*, **1996**, 93: 249 – 296.